

Supermassive black holes as the regulators of star formation in galaxies

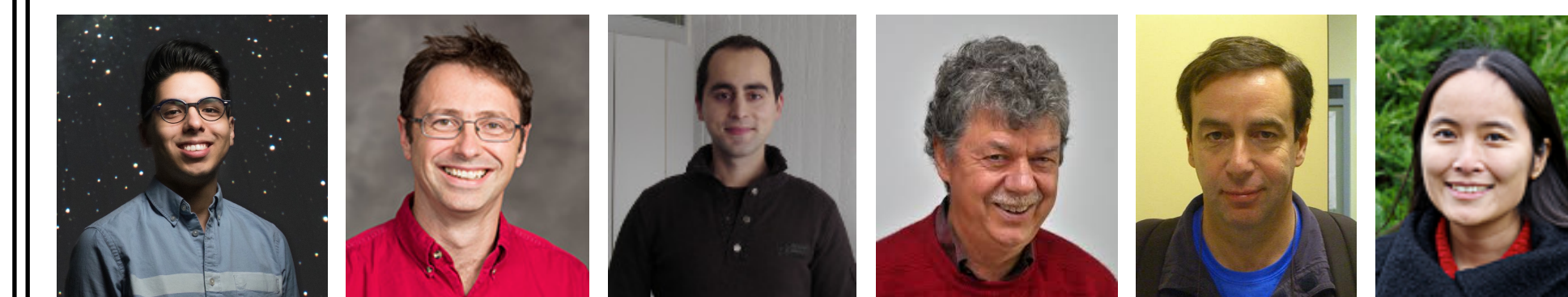
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Quiescence is one of the central observational features of many galaxies in the local and distant Universe. Yet, it is unclear what drives quiescence – is it feedback from AGN accretion, a change in cooling mode at high halo mass, a change in star formation efficiency in steep potentials, or something else entirely?

Fig. 1: Trends in galaxy properties as a function of quiescence. (top panels: M_{halo} vs M_{BH} , bottom panels: M_* vs M_{BH} ; see also Terrazas+2016, MNRAS, 370, 645).

➔ These models predict clear observationally testable patterns in quiescence as a function of black hole mass and stellar mass.

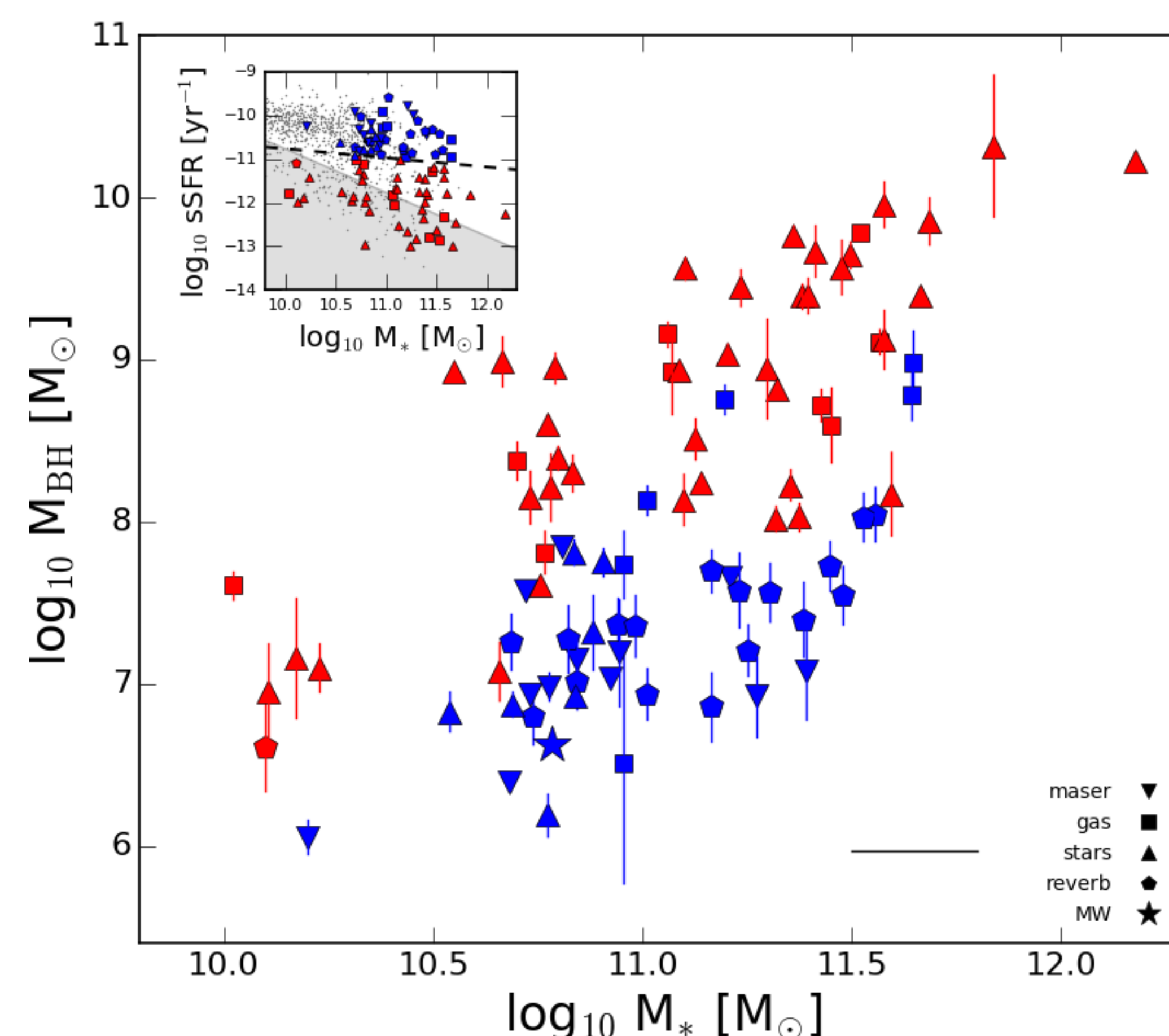


Fig. 2: Quiescence (shown in red) is a strong function of black hole mass at a given stellar mass

This observational result strongly resembles models in which quiescence is driven by long-lived, effective feedback from AGN (left panels of Fig. 1). This strongly implicates the black hole in driving quiescence.

Black hole data from Saglia+2016 (ApJ, 818, 47) and van den Bosch 2016 (arXiv:1606.01246). All galaxies are color-coded by IR-derived star formation rates (upper left panel).

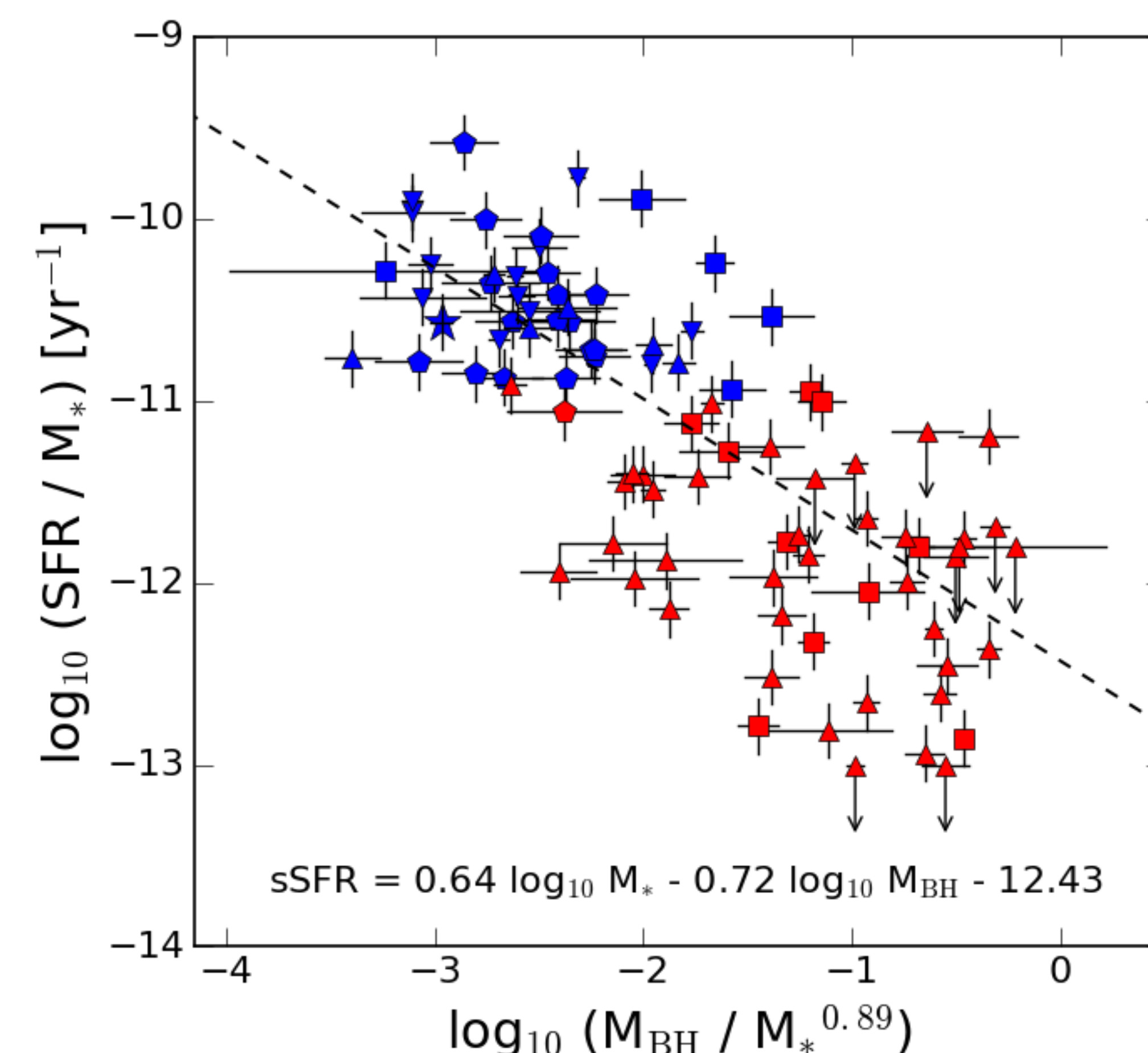


Fig. 3: Specific star formation rate is a strong function of the ratio of black hole mass to stellar mass (black hole prominence). This is an ‘edge-on’ projection of Fig. 2.

Galaxies exhibit varying degrees of quiescence, even in the star forming main sequence – the more prominent the black hole, the more quiescent the galaxy. Galaxies with intermediate degrees of quiescence tend to be early-type spirals (e.g., M31, M81), indicating that quiescence is a long-term equilibrium state, not an event.

Galaxy Formation Models

SAM	Hydro	Hydro	SAM
Strong AGN feedback	Strong AGN feedback	Short-lived AGN feedback	Halo quenching + weak AGN
Henriques+2015 MNRAS, 451, 2663	Vogelsberger+2014 MNRAS, 444, 1518	Schaye+2015 MNRAS, 446, 521	Cattaneo+2006 MNRAS, 370, 1651

